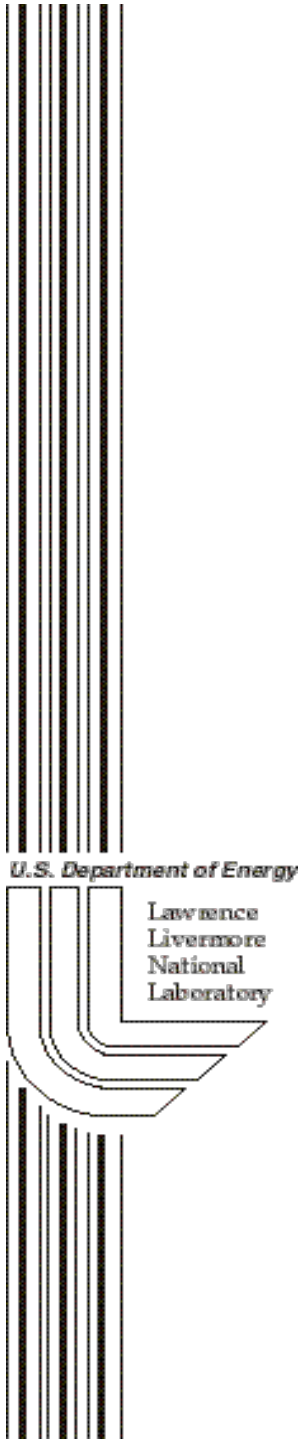


UCRL-ID-18991-99

California Energy Flow—1999

Gina V. Kaiper

May 2003

DISCLAIMER

This work was performed under the auspices of the U. S. Department of Energy by the University of California, Lawrence Livermore National Laboratory under Contract No. W-7405-Eng-48.

UCRL-ID-18991-99

California Energy Flow—1999

Gina V. Kaiper

May 2003

This work was performed under the auspices of the U.S. Department of Energy by the University of California, Lawrence Livermore National Laboratory under Contract No. W-7405-Eng-48.

Contents

	Page
California Energy Flow: Background Information	**1**
Background	1
Data Sources	1
Description of End-Use Sectors	4
Energy Content	4
Conversion Efficiency Factors	5
Nonfuel Use	6
Notes on Electricity Generation and on Primary Resources	**7**
Electricity Generation	7
Coal	8
Hydroelectric Power	9
Natural Gas	9
Nuclear Energy	9
Other Renewables	10
Petroleum and Natural Gas Plant Liquids (NGPL)	11
Comparison to Other States and the Nation	**13**
References	**19**
Appendix: Selected Tables	**21**

Tables

		Page
1.	California natural gas supply and consumption, 1999	9
2.	Renewable electric power industry net generation in 1999	11
3.	Electric power generation from geothermal energy in 1999	11
4.	Electric power generation from wind energy in 1999	11
5.	Electric power generation from solar/photovoltaic energy in 1999	11
6.	Energy consumption of five most populous states, 1999	13
7.	Gross state/domestic product and energy consumption, 1999	14

Figures

1.	California Energy Flow Trends—1999	2
2.	U.S. Energy Flow—1999	3
3.	Electricity generated by other renewables in 1999 for (a) California and (b) the United States as a whole	10
4.	Percentage of in-state/domestic production and imports for 1999 energy consumption for (a) California and (b) the United States	15
5.	Total 1999 energy consumption by source for (a) California and (b) the United States	16
6.	(a) California electricity (net system power mix) and (b) U.S. electricity generation by source, 1999	17
7.	Energy consumption in 1999 by end-use sector for (a) California and (b) the United States	18

California Energy Flow: Background Information

Background

The Figure 1 flow chart shows California energy consumption in 1999. Lawrence Livermore National Laboratory (LLNL) has prepared similar flow charts of U.S. and California energy consumption since the early 1970s. However, this is the first California chart prepared by LLNL since 1994, and there have been some changes—both in our approach and in the California energy picture—since 1994.

For this chart, we use the same overall methodology and assumptions as for the U.S. energy flow charts. Figure 2, the U.S. chart for 1999, is included for comparison. The report (Ref. 1) explaining the U.S. chart is available on the Web at **http://en-env.llnl.gov/flow/** .

The 1999 California chart follows the flow of individual fuels from production (or importation) through consumption by the major end-use sectors. The chart also shows in a general way the proportion of energy (i.e., heat) that is lost because of conversion processes.

This chart compares the flow of fuels on the basis of a common energy unit of trillion British thermal units (10^{12} Btu), and the width of each colored bar across this chart is in proportion to the number of trillion Btu conveyed. (Exception: lines showing extremely small amounts have been made wide enough to be clearly visible.) One Btu is the quantity of heat needed to raise the temperature of 1 pound of water by 1°F at or near 39.2°F. In metric terms, 1 Btu equals 1,055.056 joules.

In most cases, the numbers shown on this California chart have been rounded to the nearest trillion Btu, although the original data was published in hundredths or thousandths of a trillion Btu. Because of independent rounding, summary numbers may not appear to be a precise total of their various components.

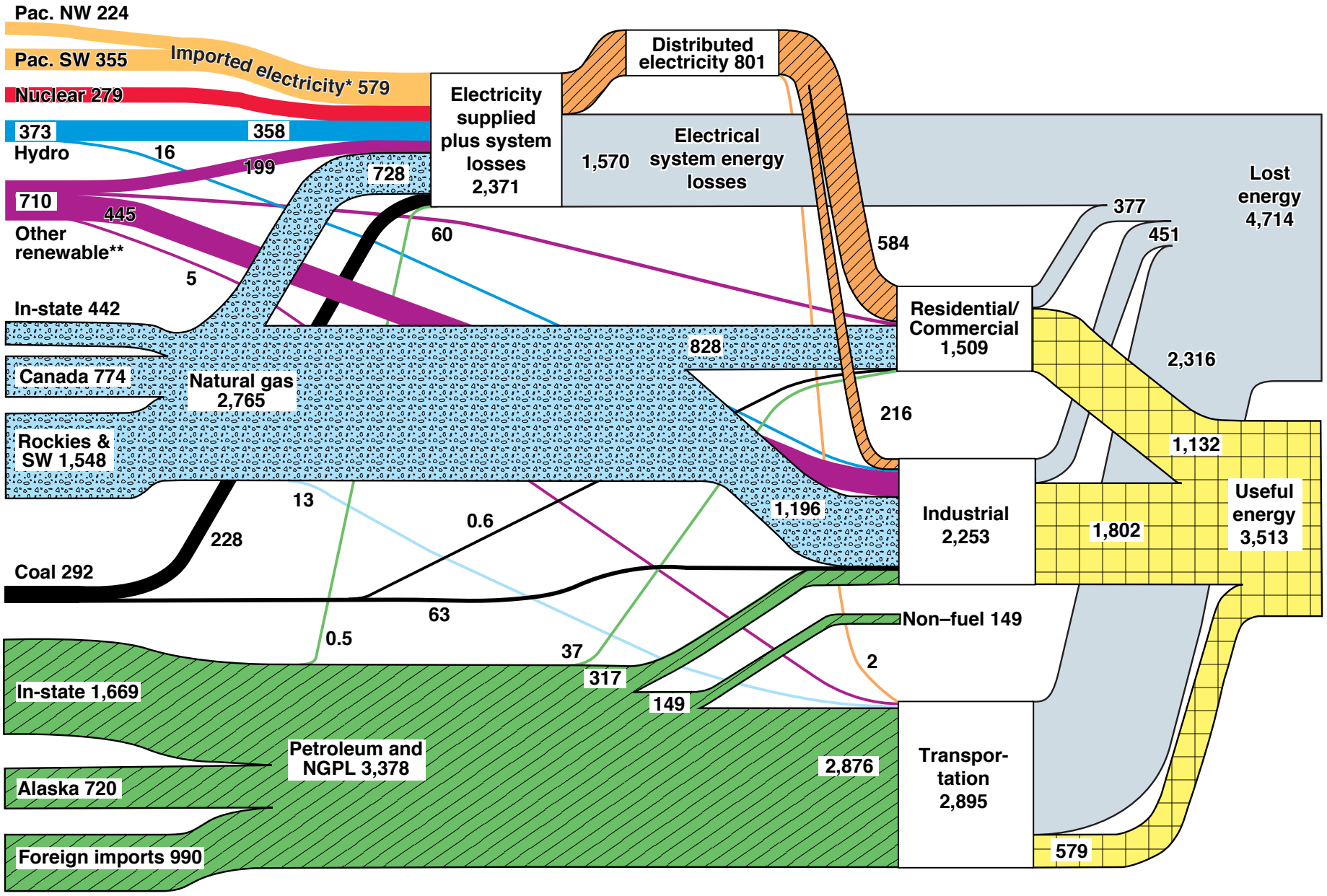
Data Sources

This chart is based upon production and end-use data compiled by the U.S. Department of Energy's Energy Information Administration (EIA) and by the California Energy Commission (CEC).

The backbone data for this chart is from the EIA's *State Energy Data Report 1999* (SEDR99), which tallies consumption by the end-use sectors (Ref. 2, Tables 42–46, pp. 54–58). For ease of reference, some of the key tables from the EIA report are included as an appendix to this document. The entire report is available on the Web at http://www.eia.doe.gov/emeu/sedr/contents.html .

Figure 1. California Energy Flow Trends– 1999

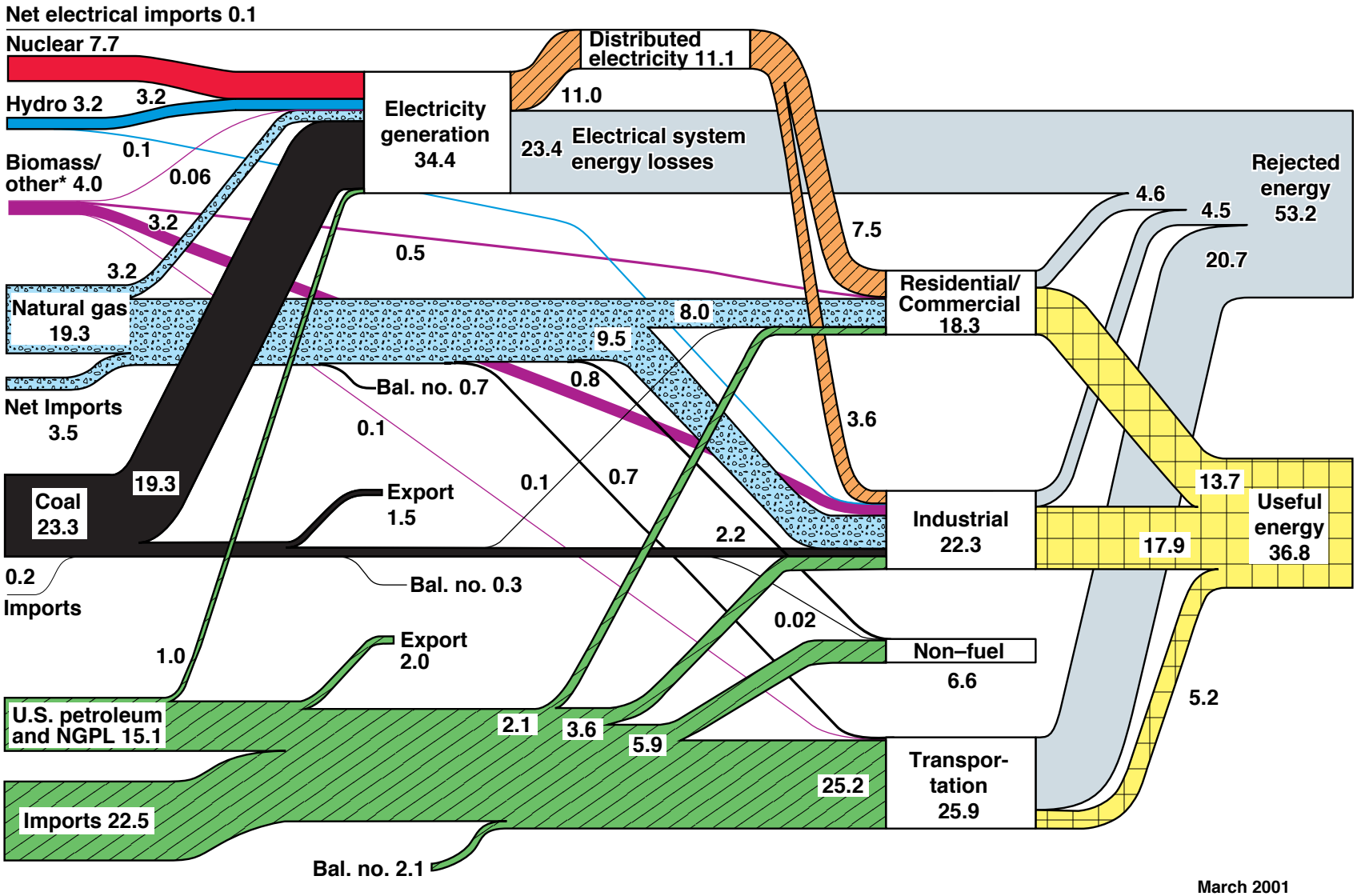
Net Primary Resource Consumption ~8375 Trillion Btu (8.375 Quads)



Sources: U.S. Department of Energy's Energy Information Administration and California Energy Commission.
*Electricity flowing into the California control areas: CAISO, LADWP, and IID.
**Other renewable includes geothermal, wood and waste, solar, and wind.

May 2003
Lawrence Livermore
National Laboratory
http://en-env.llnl.gov/flow

Figure 2. U.S. Energy Flow – 1999
Net Primary Resource Consumption 97 Quads



Source: **Production and end-use data from Energy Information Administration,** Annual Energy Review 1999
*Biomass/other includes wood and waste, geothermal, solar, and wind.

March 2001
Lawrence Livermore
National Laboratory

The EIA collects its data through a complex system of surveys. Some of these surveys focus on the suppliers and marketers of energy sources. Other surveys, geared to consumption, gather information from the end-users of energy. The EIA's estimates for the SEDR generally compare to the statistics in its *Annual Energy Review.* Our U.S. flow chart for 1999 was based primarily on EIA's *Annual Energy Review 1999* (Ref. 3). (Note that there may have been revisions to EIA's 1999 data since our U.S. chart was prepared.)

There are variations in the energy numbers published by the EIA and the CEC. Some of these differences derive from how the information is categorized or defined or from when the information was published.

In general, for this California chart we have relied upon the consumption totals developed by the EIA for the amounts of energy consumed by the end-use sectors, but we have used the CEC's proportions to show the origins of the energy sources consumed within California.

LLNL's chart is one graphical way of looking at the overall California energy picture and is intended to show trends. We do not independently collect energy data. The reader is referred to the original data for greater precision. (Some of the EIA and CEC estimates are included in the appendix to this document.)

Description of End-Use Sectors

The ***Residential/Commercial*** sector includes private and institutional residences; business establishments not engaged in transportation or manufacturing; commercial establishments; religious and nonprofit organizations; health, social, and educational institutions; and federal, state, and local governments. Electricity used for public street and highway lighting is also included. Although the EIA maintains separate numbers for the residential and the commercial sectors, we have combined these into one sector.

The ***Industrial*** sector includes agriculture, manufacturing industries, mining, construction, fisheries, and forestry. Establishments range from large manufacturing enterprises to small farms.

The ***Transportation*** sector includes all types of public and private vehicles that transport people and commodities. This sector also includes the energy used to transport natural gas in pipelines.

Energy Content

The energy flow chart shows all energy streams in terms of a common energy unit: trillion Btu. The EIA typically uses conversion factors that represent the gross heat content of the fuel, which is the total amount of heat released when fuel is burned (i.e., the "higher heating value").

Appendix C of SEDR99 (Ref. 2, pp. 469–486) gives the thermal conversion factors used in that report. The heat content that EIA lists depends on the source, type, year of production, and the sector using the fuel. (For example, the average heat content of the coal consumed by the U.S. industrial sector in 1999 was 22.1 million Btu per short ton of coal, slightly higher than the 20.3 average listed for coal consumed by U.S. electric utilities.)

Some general conversion factors, useful for rough estimation, include:

Fuel	*Energy content (Btu)*
Short ton of coal	21,400,000
Barrel (42 gallons) of crude oil	5,800,000
Cubic foot of natural gas (at standard conditions)	1,027
Kilowatt-hour of electricity	3,412

Conversion Efficiency Factors

The California chart for 1999 assumes the same conversion efficiencies for the residential/commercial, industrial, and transportation sectors as for the U.S. chart. These conversion efficiencies are used to estimate the proportion of "useful" energy to "lost" (or "rejected") energy. The uncertainties in these conversion estimates are large.

For electricity generation, the electrical system energy losses are assumed by the EIA to be about two-thirds of the energy consumed. LLNL's California chart for 1999 shows electrical system energy losses of 1570 trillion Btu, which is the sum of the amounts shown for the individual sectors in SEDR99 (Ref. 2, Tables 42–45, pp. 54–57)—that is, 503.4 trillion Btu for residential, 640.2 for commercial, 422.6 for industrial, and 3.6 for transportation.

According to the EIA (Ref. 3, p. 240, Note 1), "Electrical system energy losses are estimated as the difference between total energy input at electric utilities and the total energy content of electricity sold to end-use consumers. Most of these losses occur at steam-electric power plants (conventional and nuclear) in the conversion of heat energy into mechanical energy to turn electric generators. This loss is a thermodynamically necessary feature of the steam-electric cycle." Transmission and distribution losses, which are not spelled out separately on this chart, are normally estimated to be about 9% of the gross generation of electricity.

The conversion efficiency factors for the residential/commercial and the industrial sectors are based on engineer's estimates for the conversion efficiency of devices such as process heaters and boilers.

For the residential/commercial sector, we assume an efficiency of 75%. This is a weighted average between space heating at approximately 60% efficiency and motors and other electrical uses at about 90% efficiency.

For the industrial sector, we assume a conversion efficiency of 80%.

For transportation, we assume a generous 20% efficiency, which corresponds to the approximate average efficiency of internal combustion engines as measured on Federal Driving Schedules (i.e., the amount of energy that actually reaches the drive train of a vehicle, compared to the amount of energy consumed. Note that the peak efficiencies of 33–35% for spark-ignited engines and 41–45% for diesel engines are not representative of conversion efficiencies over the Federal Driving Schedules.)

Nonfuel Use

In the United States in 1999, "nonfuel" consumption accounted for 6.9% of the primary energy resources consumed. Because these resources are not used for energy purposes, however, LLNL's flow chart does not assign "lost" and "useful" designations for this consumption.

SEDR99 does not specify the resources used for nonfuel purposes. However, we have assigned the 135.1 trillion Btu of asphalt and road oil and the 13.5 trillion Btu of lubricants (SEDR99, Ref. 2, Table 44, p. 56) used by the industrial sector to this nonfuel category. These amounts have been subtracted from the petroleum consumed by the industrial end-use sector.

Notes on Electricity Generation and on Primary Resources

Electricity Generation

The electricity consumption numbers on this California chart came from the EIA's SEDR99. This chart also assumes that the related "electrical system energy losses" represent energy resources consumed in California, although the heat loss from conversion may have occurred at a generating plant not physically within the state.

California imports a large proportion of the electricity consumed within the state, but the EIA and the CEC differ in what constitutes "imported" electricity.

EIA considers all electricity generated beyond the borders of a state to be imported (more specifically, to be "net interstate flow" of electricity.) Thus SEDR99 (Ref. 2, Table 41, p. 53) shows 416,346 million kWh or 1,420.6 trillion Btu flowing in from other states.

For this chart, however, we have relied upon the CEC's definition of imported electricity, as indicated in Ref. 4, which counts only 67,290 million kWh as imported. (Note that Ref. 4 gives kilowatt hours of electricity *generated*, not consumed, and does not incorporate system losses; the 67,290 million kWh listed as imported represents 24.4% of the total of 275,805 million kWh.) In Ref. 4, "import" is defined as the net flow into the three California control areas: the California Independent System Operator (CAISO), the Los Angeles Department of Water and Power (LADWP), and the Imperial Irrigation District (IID). Thus electricity generated by plants that are physically beyond the state borders but that are within one of the three control areas is not considered imported.

For the components of electricity in this chart (that is, both the electricity consumed and the related electrical system losses), we used the same proportions for primary resources and imported electricity that are given in Ref. 4, except that we combined large and small hydro. Thus the proportions used in our chart are:

- Natural gas 30.71%
- Hydro 15.09%
- Nuclear 11.77%
- Coal 9.60%
- Other renewables 8.40%
- Petroleum 0.02%
- Imported electricity 24.40%

We have not defined the specific primary resources used to generate the imported electricity. However, for 1994 the CEC assumed that 80% of the electricity imported from the Pacific Northwest was from hydroelectricity and that the remaining 20% of imports from that region was generated from coal. (Ref. 5, p. 3) The CEC also

assumed that 74% of the electricity imported from the Southwest was generated from coal and 26% from natural gas. The CEC used those assumptions in determining the 1999 California power mix (Ref. 5). Note that, because we did not define the resources for imported electricity, the percentages shown above differ from those in the 1999 California power mix, which lists the following percentages:

- Natural gas 31.0%
- Hydro, large 20.1%
- Nuclear 16.2%
- Coal 19.8%
- Biomass & waste 2.0%
- Geothermal 4.9%
- Hydro, small 3.4%
- Solar 0.4%
- Wind 1.5%
- Other 0.6%

The electricity numbers used on this chart are totals for the power industry. With continuing deregulation of the electric power industry, an increasing proportion of the electricity generated in the United States—and especially in California—is now provided by what the EIA designates as "nonutility" power producers. Because of deregulation, some utilities have sold their power plants to nonutility owners, a process that in California began before 1999. During 1999 California utilities divested power plants with 6,265 MW of capacity, mostly natural-gas-fired but also including a 1,224-MW geothermal plant (Ref. 6, p. 4).

EIA considers the nonutility power producers to include (1) cogenerators that provide both electricity and steam or heat for industrial or other purposes; (2) small power producers that use renewables for at least 75% of their output; and (3) independent power producers that are unaffiliated with franchised utilities, do not possess transmission facilities, and do not sell power in the retail service area where they have a franchise.

Coal

Although coal supplied 22.8% of the United States' energy in 1999, in California coal accounted for only 3.5% of the total energy consumption, and the majority of that was used to generate electricity.

In the United States in 1999, coal was burned to produce more than half of the nation's electricity. Even in California, coal is used to generate a significant proportion of the electricity consumed within the state, although most of the coal-burning power plants are physically located outside the state.

Our chart shows 228 trillion Btu of coal going to the generation of electricity, which represents 9.6% of the total electricity consumed in the state (including system losses.) Based on its assumptions relating to the resources used for "imported" electricity, the CEC said that in 1999 the net system power mix included 19.8% from coal (Ref. 5, p. 4). On its "Power Content Label" Web page (Ref. 7), the Los Angeles Department of Water and Power projects that 51% of its power is generated from coal (no

date given.) LADWP's Intermountain Plant in Utah uses coal as its primary resource.

Hydroelectric Power

This involves the production of power from falling water that turns a turbine generator. For this chart, we have grouped together both "large" hydro and "small" hydro, which the CEC defines as less than 30 MW (Ref. 5, p. 4).

Natural Gas

According to the EIA (Ref. 2, Table 41; and Ref. 8, Table 46), California in 1999 consumed 2,146 billion cubic feet of natural gas, which converts to 2,182.4 trillion Btu. To show the source of this natural gas, we used the EIA number for total consumption but applied to this amount the CEC's proportions for sources: 16% produced in California, 10% from the Rocky Mountain region, 46% from the Southwest, and 28% from Canada (Ref. 9, p. 10). Thus the flow chart assumes that in 1999 about 442 trillion Btu of the natural gas consumed in California came from in-state production, 774 trillion Btu were imported from Canada, and about 1,548 trillion Btu were imported from the Southwest/Rocky Mountains.

According to the CEC (Ref. 9, p. 24), four major interstate pipelines bring the gas to California. Canadian gas enters the Pacific Gas & Electric Company's pipeline system at Malin, Oregon. Gas from the Rocky Mountains enters the state via the Kern River pipeline in the southern San Joaquin Valley. Natural gas from fields in the southwestern United States enters the state at several locations along the California–Arizona border.

The EIA's *Natural Gas Annual 2000* (Ref. 8, Table 46, pp. 91–92) provides more detail about natural gas in California. Table 1 summarizes some of the EIA statistics.

Table 1. California natural gas supply and consumption, 1999, in billion cubic feet (Source: Ref. 8, Table 46)

In-state dry production	372.0
Net interstate imports	1,791.5
Net withdrawal from storage	8.3
Total supply	2,171.7
Balancing number	–25.6
Total consumption	2,146.0

About 79% of the in-state production came from oil wells, with the remainder from gas wells. About 137 billion cubic feet, or 6% of the state's natural gas supply, was withdrawn from underground storage, but in turn about 128 billion cubic feet was added to underground storage during the year.

In 1999, California consumed 3,327 million cubic feet of natural gas as vehicle fuel, which was about 59% of the 5,685 million cubic feet used for vehicle fuel by the United States as a whole. (Ref. 8, Tables 1 and 46.)

Nuclear Energy

In 1999, nuclear energy accounted for 11.8% of the state's electricity; in the United States as a whole, the nuclear share of total electricity was 19.8%. The state's two

largest power plants are both nuclear: Pacific Gas and Electric Company's Diablo Canyon plant, with a net summer capability of 2,160 MW, and Southern California Edison Co.'s San Onofre plant, with a net summer capability of 2,150 MW. (Ref. 10, Table 2.)

Other Renewables

California's 710 trillion Btu in the "Other Renewables" category (that is, "other" than hydroelectricity) accounts for 17.7% of the "Other Renewables" energy consumed by the United States in 1999. This category includes biomass material, wood and waste, and geothermal, wind, and solar energy. In California, the largest share of "other renewable" energy was consumed by the industrial sector, but 199 trillion Btu was used to generate electricity.

As Figure 3 shows, in California in 1999, geothermal energy accounted for 60.4% of the electricity generated by "Other Renewables," with various forms of wood and waste (including landfill gas) accounting for 23.1%, wind for 13.1%, and solar/photovoltaic (PV) for 3.4%. (Ref. 11, Table C7.)

By contrast, for the United States as a whole, wood and waste accounted for 72.2% of the electricity generated by "Other Renewables," geothermal for 21.1%, wind for 5.6%, and solar/PV for 1.1.% (Ref. 11, Table C7)

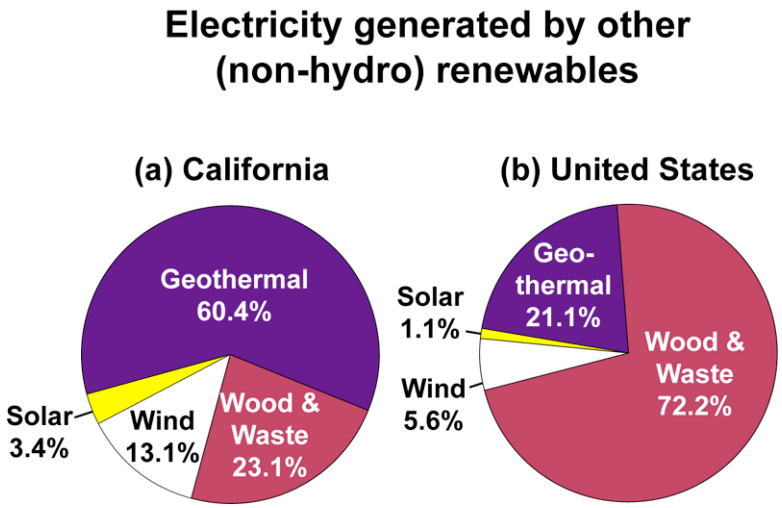


Figure 3. Electricity generated by other renewables in 1999 for (a) California and (b) the United States as a whole.

When hydro is not included, California accounts for about 31% of the renewable-generated electricity in the United States. When hydro *is* included, California accounts for 16.4%. As shown in Table 2, California is the second-largest generator of renewable electricity in the United States, behind the state of Washington, which is rich in hydroelectric resources. Except for California, the states shown in this table generate almost all their "renewable" electricity from hydro. (Ref. 11, Table C7)

Table 2. Renewable electric power industry net generation in 1999, in megawatt-hours (Source: Ref. 11, Table C7)

Washington	98,335,960
California	**65,453,604**
Oregon	46,177,101
New York	27,476,091
Idaho	13,929,802
Montana	13,822,062

As shown in Tables 3–5, California is the leading producer of electricity from geothermal, wind, and solar/PV energy.

Table 3. Electric power generation from geothermal energy in 1999, in megawatt-hours (Source: Ref. 11, Table C7)

California	**14,933,071**
Nevada	1,425,509
Hawaii	210,857
Utah	155,530
New Hampshire	87,643
(no others listed)	

Table 4. Electric power generation from wind energy in 1999, in megawatt-hours (Source: Ref. 11, Table C7)

California	**3,229,953**
Minnesota	485,692
Iowa	326,354
Texas	319,960
Oregon	84,792

Table 5. Electric power generation from solar/photovoltaic energy in 1999, in megawatt-hours (Source: Ref. 11. Table C7)

California	**847,869**
Texas	186
(no others listed)	

Petroleum and Natural Gas Plant Liquids (NGPL)

This category includes both crude oil and natural gas plant liquids (i.e., hydrocarbons in natural gas that have been separated as liquids.) The transportation sector consumed about 85% of the petroleum consumed in California in 1999.

According to the EIA (Ref. 2, Tables 1 and 2, and Ref. 12), as a state California ranked second in total consumption of petroleum in 1999 (after Texas), first in gasoline consumption, and second in both distillate fuel consumption and jet fuel consumption. However, in 2000 California also ranked third among states in petroleum production (fourth when Federal offshore production is included) and in 1999 ranked third in proved reserves of crude oil. California had 42,604 producing oil wells in 2000 and, with 23 refineries, is a major refining center for West Coast petroleum markets. In addition, ports in both northern and southern California receive shipments of crude oil from the Alaska North Slope.

For this flow chart, we have used EIA's numbers for petroleum consumption (Ref. 2) but have relied upon the CEC's percentages regarding the sources of that petroleum—that is, 49.4% from within the state, 21.3% from Alaska, and 29.3% from foreign imports (Ref. 13). According to the CEC, California's in-state production has been decreasing about 2% per year. (Ref. 14, p. 2)

EIA's data (Ref. 2, Tables 41–45) show that 52% of California's petroleum consumption in 1999 was in the form of motor gasoline, 16.5% was jet fuel, and 12.9% was distillate fuel, used primarily as diesel fuel. Of the total distillate fuel sold in California in 1999, 67.1% was for on-highway use, 10.7% was for farm use, and 7.4 % for railroads. (Ref. 15, Table 4, pp. 13–16)

Note that on our chart the 5 trillion Btu of ethanol blended into motor gasoline has been shown as a separate line of "Other renewables" consumed by the transportation sector. That amount has been subtracted from EIA's number for petroleum consumed by transportation. (Ref. 2, Table 45, note "c," p. 57)

According to the CEC, in 2000 Californians registered about 22 million gasoline-powered vehicles, with another 120,000 vehicles operating on liquefied petroleum gas, natural gas, alcohol, or electricity. (Ref. 14, Appendix B, p. 4). In 2000, the on-road vehicle miles traveled (VMT) in California totaled 295 billion miles, including light-duty vehicles, freight, and transit. (Ref. 14, Appendix B, p. 5)

Comparison to Other States and the Nation

California, with a 1999 population of more than 33 million people, is by far the nation's most populous state, well ahead of second-place Texas, with about 20 million. (Ref. 2, Table D4, p. 491)

However, in energy consumption, California ranks mostly second, behind Texas, in:

- Total energy consumption.
- Petroleum consumption.
- Natural gas consumption.
- Electricity consumption.
- Energy consumption by the industrial sector.

On the other hand, California ranks first in energy consumption by the residential and transportation sectors, ahead of Texas, and also first in energy consumption by the commercial sector, ahead of New York (Ref. 2, Tables 3–7 and 10).

Although the overall energy consumption numbers for California are large, in fact California ranks near the bottom in per-capita energy consumption, as shown in Table 6. California's per-capita energy consumption at 252.7 million Btu/person is about 72% of the U.S. average of 350.9 million Btu/person. Thus, with 12.2% of the U.S. population, California accounts for only 8.8% of total U.S. energy consumption and only 8.9% of U.S. petroleum consumption.

Table 6. Energy consumption of five most populous states, 1999. (Source: Ref. 2, Tables 1, 9, 10, and D4)

State	Population	% of U.S. population	Total energy consumption (trillion Btu)	% of U.S. energy consumption	% of U.S. petroleum consumption	Per capita energy consumption (million Btu)	Per-capita energy use rank among 50 states/DC
California	33,145,121	12.2	8,375.4	8.8	8.9	252.7	49
Texas	20,044,141	7.3	11,501.0	12.0	14.7	573.8	5
New York	18,196,601	6.7	4,283.0	4.5	4.4	235.4	50
Florida	15,111,244	5.5	3852.9	4.0	5.0	255.0	47
Illinois	12,128,370	4.4	3,882.6	4.1	3.5	320.1	36
U.S. Total	**272,690,813**	**100**	**95,682.4***	**100**	**100**	**350.9**	**—**

*Note that Ref. 3 gives total U.S. consumption of 96.6 quadrillion Btu.

Energy consumption and the distribution of resources are affected by many factors, including population growth, economic health, supply/demand (and cost) of resources, emphasis on conservation and efficiency, geography, weather, business practices, and public policy. For example, economic fluctuations particularly impact energy use in the industrial and transportation sectors. Weather conditions affect energy use in the residential/commercial sector, affecting the amount of winter heating and summer cooling required. Geography affects the availability of primary resources, vehicle miles traveled, and the configuration of pipelines and distribution systems.

Not only does California have a larger population than any other state, but it also has the largest economy. In 1999 California's gross state product (GSP) was $1,185.636 Billion (in 1996 dollars), which was about 13.4% of that year's U.S. gross domestic product (GDP) of $8,848.2 Billion (in chained 1996 dollars) (Ref. 16, Table D.1, p. 58, and Ref. 3, Table 1.5, p. 13).

As Table 7 shows, however, California energy consumption per dollar of GSP is about 65% that of U.S. energy consumption per dollar of GDP.

Table 7. Gross state/domestic product and energy consumption, 1999. (Source: Ref. 16, Table D.1, and Ref. 3, Table 1.5)

	California	United States
Gross state/ domestic product (billions of 1996 dollars)	1,185.636	8,848.2
Total energy consumption (trillion Btu)	8,375	96,600
Btu per 1996 $ of GSP/GDP	7,064	10,920

Grouping the numbers used on the California and U.S. energy flow charts and putting them into a different format, as the pie charts of Figure 4, makes it clear that California imports a far larger proportion (55%) of the energy consumed than does the United States as a whole (24.8%).

The state's energy imports may not have the national security implications of depending, for example, on petroleum imports from the Middle East—in 1999, only about 29% of California's petroleum came from outside the United States, while the United States imported more than 55% of its petroleum. Still, that foreign oil represented about 12% of the state's energy consumption.

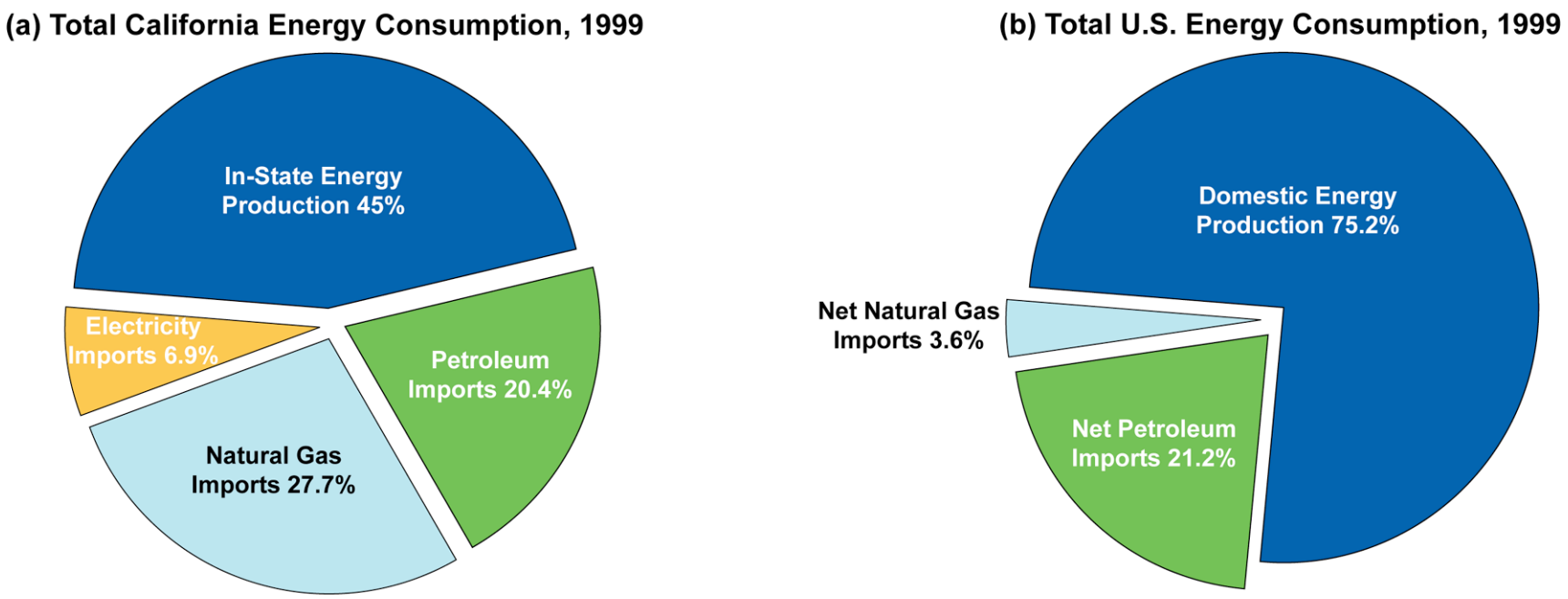


Figure 4. Percentage of in-state/domestic production and imports for 1999 energy consumption for (a) California and (b) the United States.

As Figure 5 shows, in 1999 California and the United States consumed about the same proportions of petroleum within the overall resources mix. However, California consumed a far smaller proportion of coal and much larger proportions of natural gas and renewable energy. This has implications for the emissions of carbon dioxide and other "greenhouse" gases, because the combustion of coal emits more CO_2 per unit of energy than does the combustion of natural gas.

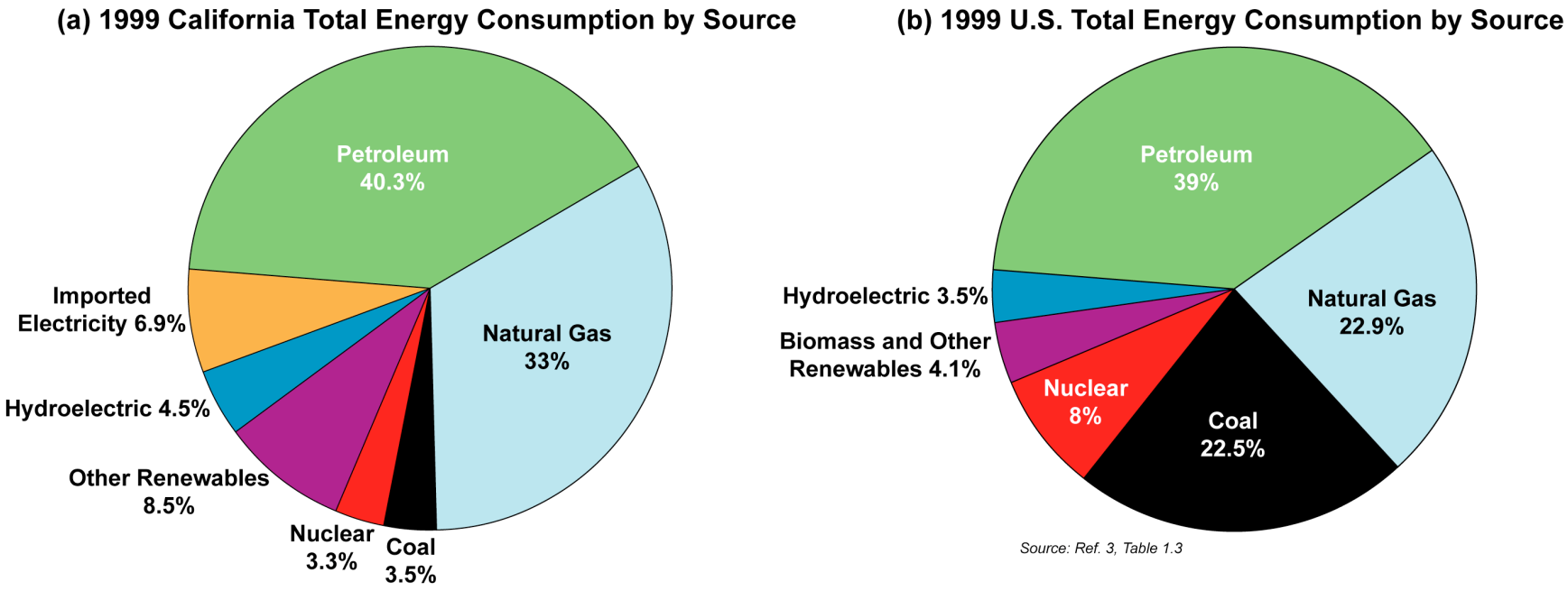


Figure 5. Total 1999 energy consumption by source for (a) California and (b) the United States.

Figure 6, which depicts the resource mix for the electricity consumed, shows that California relied on a more diversified resource mix (i.e., power mix, Ref. 5) than the national as a whole. Only 19.8% of the electricity that California consumed in 1999 was generated by coal, compared to 51.4% for the nation. Equally important, from the standpoint of CO_2 emissions, is that 48.5% of the electricity that California consumed derived from sources—hydroelectricity, other renewables, and nuclear—that emit no CO_2. This compares to about 30.4% for the United States.

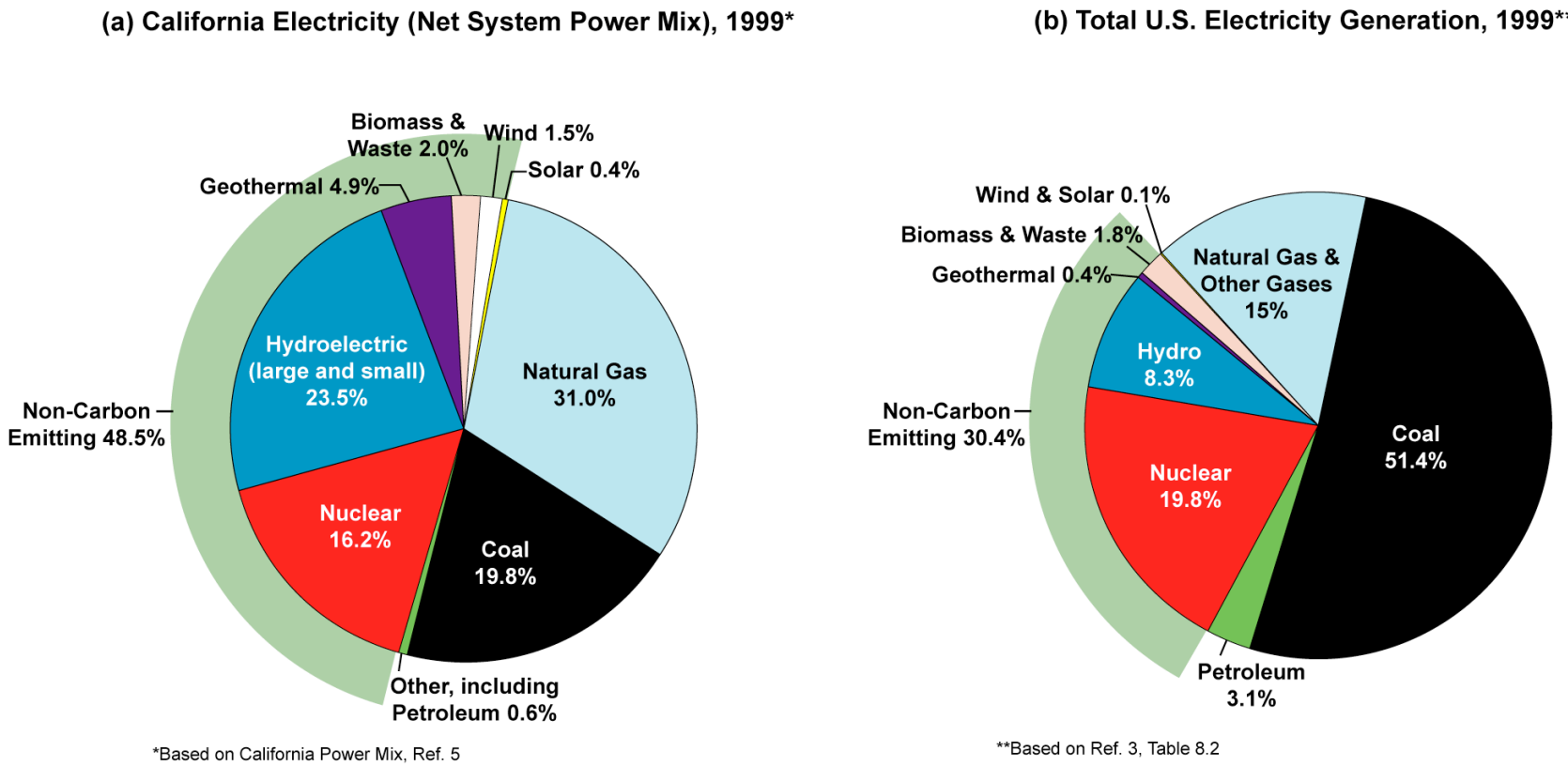


Figure 6. (a) California electricity (net system power mix) and (b) U.S. electricity generation by source, 1999.

Figure 7 shows energy consumption by end-use sector. California uses a larger proportion of its energy for transportation than does the nation as a whole. California consumed slightly smaller proportions of energy for the industrial sector (which includes agriculture) and for the residential/commercial sectors. Note that these pie charts allot "electrical system energy losses" in proportion to the electricity consumed by each sector.

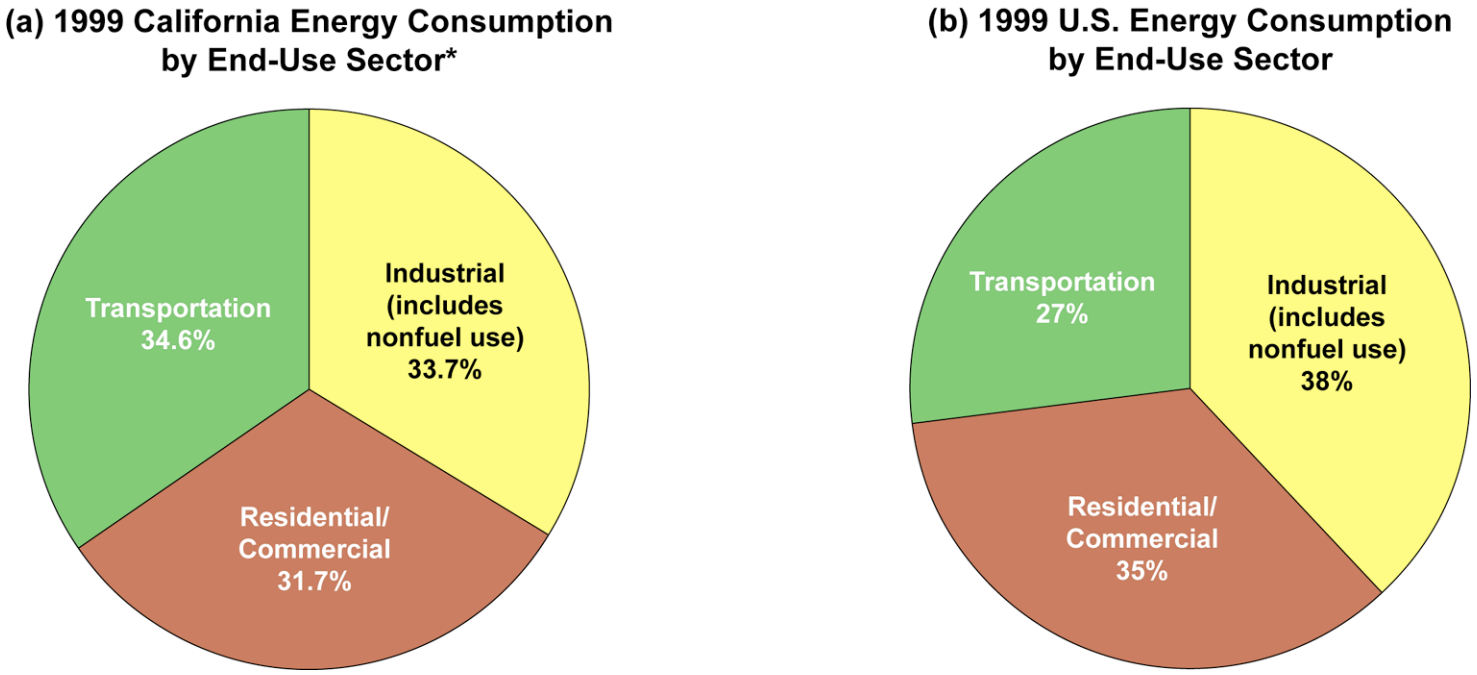


Figure 7. Energy consumption in 1999 by end-use sector for (a) California and (b) the United States.

References

1. Kaiper, G.V., *U.S. Energy Flow—1999.* Lawrence Livermore National Laboratory report no. UCRL-ID-129990-99. Livermore, CA: March 2001.

2. U.S. Department of Energy, Energy Information Administration, *State Energy Data Report 1999: Consumption Estimates.* DOE/EIA-0214(99), Washington, DC: May 2001.

3. U.S. Department of Energy, Energy Information Administration, *Annual Energy Review 1999.* DOE/EIA-0384(99), Washington, DC: July 2000.

4. California Energy Commission, "1999–2001 California Electric Generation Ownership and Fuel Type Details." Web page updated July 29, 2002. Accessed online on August 27, 2002 at http://www.energy.ca.gov/electricity/generation_ownership.html

5. State of California, Energy Resources Conservation and Development Commission, *1999 Net System Power Calculation (1999 California Power Mix.)* Adopted by the Commission April 5, 2000. Principal author: Ronald Wetherall of the California Energy Commission's Energy Information and Analysis Division.

6. U.S. Department of Energy, Energy Information Administration, *Electric Power Annual 1999,* v. I. DOE/EIA-0348(99)/1, Washington, DC: August 2000.

7. Los Angeles Department of Water and Power, "Power Content Label," Web page accessed online on August 26, 2002, at http://www.ladwp.com/power/contentlabel.htm

8. U.S. Department of Energy, Energy Information Administration, *Natural Gas Annual 2000.* DOE/EIA-0131(00), Washington, DC: November 2001.

9. California Energy Commission, *California Natural Gas Analysis and Issues.* Staff Report. P200-00-006. Sacramento, CA: November 21, 2000.

10. U.S. Department of Energy, Energy Information Administration, "State Electricity Profiles—California," pdf file downloaded on July 19, 2002, from http://tonto.eia.doe.gov/FTPROOT/electricity/062901.pdf .

11. U.S. Department of Energy, Energy Information Administration, *Renewable Energy Annual 2000 with Data for 1999.* DOE/EIA-0603(2000), Washington, DC: March 2001.

12. U.S. Department of Energy, Energy Information Administration, "Petroleum Profile: California," accessed online on August 13, 2002, at http://tonto.eia.doe.gov/oog/info/state/california.htm

13. California Energy Commission, "California's Major Sources of Energy," Web page updated May 30, 2002, and accessed on July 9, 2002, from http://www.energy.ca.gov/html/energysources.html .

14. California Energy Commission and California Air Resources Board, *Reducing California's Petroleum Dependence*. Staff Draft Report P600-03-055. Sacramento, CA: May 2003. Including "Appendix B: Base Case Forecast of California Transportation Energy Demand (Task 2),"Final Staff Report P600-03-005A2, March 2003.

15. U.S. Department of Energy, Energy Information Administration, *Fuel Oil and Kerosene Sales 1999*. DOE/EIA-0535(99). Washington, DC: September 2000.

16. California Department of Finance, *California Statistical Abstract—2001,* pdf file downloaded on October 1, 2001, from http://www.dof.ca.gov .

Appendix
Selected Tables

From the California Energy Commission
- 1999–2001 Generation Ownership & Fuel Type Details (Web page)

From EIA's *State Energy Data Report 1999*
- Table 41. Energy Consumption Estimates by Source, Selected Years 1960–1999, California
- Table 42. Residential Energy Consumption Estimates, Selected Years 1960–1999, California
- Table 43. Commercial Energy Consumption Estimates, Selected Years 1960–1999, California
- Table 44. Industrial Energy Consumption Estimates, Selected Years 1960–1999, California
- Table 45. Transportation Energy Consumption Estimates, Selected Years 1960–1999, California

1999-2001 Generation Ownership & Fuel Type Details

1999-2001 California Electric Generation									
Ownership and Fuel Type Details									
(Gigawatt hours)									
1999	**Fuel Type**	**IOU**	**MUNI**	**Federal**	**State**	**Merchant**	**QF/selfgen**	**Import**	**Total**
	Hydro, large	14,976	10,087	6,311	4,114				35,487
	Nuclear	32,472							32,472
	Coal	9,794	13,077				3,602		26,472
	Oil	35	19						55
	Natural Gas	5,056	9,939			30,958	38,752		84,705
	Geothermal	1,543	635			3,651	7,422		13,251
	Biomass		73				5,590		5,663
	Wind	3	4				3,426		3,433
	Solar	1	2				835		838
	Hydro, small	2,048	2,878	78	101		1,035		6,140
	Import, NW							26,051	26,051
	Import, SW							41,239	41,239
	Total	65,928	36,714	6,388	4,215	34,609	60,661	67,290	275,805
2000	**Fuel Type**	**IOU**	**MUNI**	**Federal**	**State**	**Merchant**	**QF/selfgen**	**Import**	**Total**
	Hydro, large	13,701	10,421	5,483	4,518				34,123
	Nuclear	33,718							33,718
	Coal	10,769	13,185				3,183		27,137
	Oil	78	79			293			449
	Natural Gas	1,103	12,644			55,072	38,058		106,878
	Geothermal		1,252			4,958	7,246		13,456
	Biomass		34				6,052		6,086
	Wind		7				3,597		3,604
	Solar	0	2				857		860
	Hydro, small	4,161	2,433	87	197		1,052		7,930
	Import, NW							18,777	18,777
	Import, SW							27,478	27,478
	Total	63,530	40,056	5,570	4,716	60,323	60,046	46,255	280,496

2001	Fuel Type	IOU	MUNI	Federal	State	Merchant	QF/selfgen	Import	Total
	Hydro, large	9,332	5,054	4,423	2,321				21,129
	Nuclear	33,294							33,294
	Coal	10,285	13,391				3,960		27,636
	Oil	315	66			453	495		1,328
	Natural Gas	867	10,680			68,951	32,647		113,145
	Geothermal		997			5,337	7,286		13,619
	Biomass		0				6,185		6,185
	Wind		7				3,235		3,242
	Solar		3				834		837
	Hydro, small	1,904	1,334	61	93	120	363		3,876
	Import, NW							6,826	6,826
	Import, SW							33,941	33,941
	Total	55,996	31,531	4,484	2,414	74,861	55,005	40,768	265,059

Import is defined as the net flow into the three California control areas: CAISO, LADWP and IID.

| Commission Homepage | Site Index | Search Site | Glossary | Links | Contact Us |

Page Updated: September 26, 2002

Table 41. Energy Consumption Estimates by Source, Selected Years 1960-1999, California

Year	Coal [a]	Natural Gas [b]	Petroleum											Nuclear Electric Power	Hydro-electric Power [d]	Wood and Waste	Other [a,e]	Net Interstate Flow of Electricity/Losses [f]	Total [g]
			Asphalt & Road Oil [a]	Aviation Gasoline [a]	Distillate Fuel [a]	Jet Fuel [a]	Kerosene [a]	LPG [a]	Lubricants [a]	Motor Gasoline	Residual Fuel [a]	Other [a,c]	Total						
	Thousand Short Tons	Billion Cubic Feet	Thousand Barrels											Million kWh				Million kWh	
1960	1,343	1,258	10,665	5,383	26,683	25,818	1,017	8,888	3,781	137,025	80,575	R 25,691	R 325,526	(s)	17,045	—	—	3,463	—
1965	2,380	1,690	11,892	3,342	35,105	40,150	817	11,029	4,482	169,900	69,745	R 28,664	R 375,126	270	30,520	—	—	-1,406	—
1970	2,327	2,126	12,084	2,184	39,221	59,614	1,004	15,532	3,967	214,064	70,324	R 35,824	R 453,818	3,132	38,071	—	—	39,011	—
1975	2,151	1,833	13,146	1,640	42,335	62,607	2,027	19,264	3,632	241,508	111,086	R 39,478	R 536,724	6,071	40,103	—	—	113,596	—
1980	2,669	1,808	18,431	285	62,277	63,201	2,117	19,197	4,907	253,593	148,701	R 49,455	R 622,165	4,920	40,868	—	—	122,895	—
1985	1,942	1,846	13,848	1,354	72,431	67,028	916	20,497	4,465	267,368	66,724	R 55,165	R 569,796	19,729	35,772	—	—	173,717	—
1990	2,899	1,864	14,862	1,106	82,559	94,907	145	19,992	5,024	305,983	64,890	R 54,940	R 644,408	32,693	R h 26,620	—	—	R 278,397	—
1991	2,816	1,971	14,251	1,091	75,409	90,064	139	18,596	4,495	298,698	45,571	R 45,165	R 593,479	31,542	R 23,111	—	—	R 301,541	—
1992	2,821	2,031	13,558	1,059	67,259	86,688	75	21,088	4,583	315,643	34,696	R 48,344	R 592,992	35,244	R 20,735	—	—	R 270,592	—
1993	2,453	1,976	12,433	819	59,089	89,244	131	16,655	4,666	308,726	37,615	R 43,672	R 573,050	31,581	R 40,791	—	—	R 239,611	—
1994	2,498	2,123	12,237	793	64,921	98,793	120	18,099	4,877	307,653	42,525	R 45,397	R 595,417	33,752	R 24,047	—	—	R 246,926	—
1995	2,618	1,925	12,212	807	68,710	95,305	164	14,798	4,793	313,464	46,957	R 42,389	R 599,599	30,246	R 50,516	—	—	R 261,421	—
1996	2,317	1,807	12,399	769	67,412	103,773	294	R 10,914	4,652	318,257	40,949	R 46,392	R 605,810	34,097	R 47,154	—	—	R 298,389	—
1997	2,134	1,947	11,512	R 836	75,787	103,144	358	R 8,854	4,914	322,871	21,864	R 44,442	R 594,582	30,512	R 42,060	—	—	R 335,645	—
1998	2,803	2,015	15,572	574	79,028	105,385	474	10,936	5,145	329,943	18,281	38,703	604,043	34,594	51,641	—	—	321,909	—
1999	2,783	2,146	20,366	825	74,662	98,673	288	12,171	5,198	337,791	28,565	39,220	617,760	33,372	41,075	—	—	416,346	—
			Trillion Btu																
1960	35.9	1,301.8	70.8	27.2	155.4	140.7	5.8	35.7	22.9	719.8	506.6	R 153.9	R 1,838.7	(s)	183.4	82.1	0.8	11.8	R 3,454.5
1965	63.7	1,813.2	78.9	16.9	204.5	222.2	4.6	44.2	27.2	892.5	438.5	R 168.7	R 2,098.2	3.2	319.0	97.5	4.2	-4.8	R 4,394.2
1970	61.8	2,241.3	80.2	11.0	228.5	332.9	5.7	58.7	24.1	1,124.5	442.1	R 210.6	R 2,518.2	34.4	399.5	116.8	11.3	133.1	R 5,516.5
1975	56.4	1,937.3	87.2	8.3	246.6	350.7	11.5	71.6	22.0	1,268.6	698.4	R 232.3	R 2,997.3	66.9	417.3	127.5	70.2	387.6	R 6,060.4
1980	66.2	1,890.9	122.3	1.4	362.8	354.2	12.0	70.5	29.8	1,332.1	934.9	R 289.5	R 3,509.6	53.7	424.5	R 134.0	109.8	419.3	R 6,607.9
1985	45.3	1,925.5	91.9	6.8	421.9	375.8	5.2	73.8	27.1	1,404.5	419.5	R 327.2	R 3,153.7	213.3	373.7	R 155.5	195.7	592.7	R 6,655.4
1990	65.3	1,923.7	98.6	5.6	480.9	534.7	0.8	72.5	30.5	1,607.3	408.0	R 323.2	R 3,562.0	349.2	R h 276.9	R 196.1	R h 380.6	R 949.9	R h 7,727.1
1991	64.0	2,023.9	94.6	5.5	439.3	508.1	0.8	67.2	27.3	1,569.1	286.5	R 267.9	R 3,266.2	338.8	R 241.2	R 185.9	R 385.9	R 1,028.9	R 7,550.2
1992	64.8	2,089.5	90.0	5.3	391.8	489.5	0.4	76.4	27.8	1,658.1	218.1	R 284.6	R 3,242.1	376.3	R 214.4	R 197.8	R 391.8	R 923.3	R 7,511.7
1993	56.9	2,047.5	82.5	4.1	344.2	504.7	0.7	60.1	28.3	1,621.7	236.5	R 258.3	R 3,141.2	337.3	R 420.5	R 180.9	R 397.6	R 817.6	R 7,410.6
1994	58.0	2,172.1	81.2	4.0	378.2	560.1	0.7	65.8	29.6	R 1,609.0	267.4	R 268.4	R 3,264.3	360.3	R 248.1	R 186.1	R 399.2	R 842.5	R 7,538.7
1995	61.0	1,955.9	81.0	4.1	400.2	540.4	0.9	53.6	29.1	R 1,634.7	295.2	R 250.9	R 3,290.1	322.4	R 520.9	R 176.2	R 341.5	R 892.0	R 7,568.4
1996	53.9	1,865.1	82.3	3.9	392.7	588.4	1.7	R 39.4	28.2	R 1,660.0	257.4	R 275.4	R 3,329.4	362.2	487.6	R 175.1	R 352.5	R 1,018.1	R 7,648.2
1997	49.2	1,982.0	76.4	4.2	441.5	584.8	2.0	R 32.0	29.8	R 1,683.1	137.5	R 263.9	R 3,255.3	324.1	R 435.6	R 152.8	R 327.5	R 1,145.2	R 7,674.3
1998	64.5	2,109.5	103.3	2.9	460.3	597.5	2.7	39.5	31.2	1,719.7	114.9	230.1	3,302.2	367.5	534.3	132.4	329.4	1,098.4	7,942.4
1999	64.0	2,182.4	135.1	4.2	434.9	559.5	1.6	44.0	31.5	1,760.2	179.6	232.5	3,383.2	354.5	425.0	162.3	377.6	1,420.6	8,375.4

[a] The continuity of these data series estimates may be affected by changing data sources and estimation methodologies. See the "Additional Notes" under each type of energy in Appendix A.

[b] Includes supplemental gaseous fuels.

[c] "Other" is the subtotal of 16 petroleum products consumed in the industrial sector. See a full description in Appendix A, Section 4, "Other Petroleum Products."

[d] If applicable, through 1988, includes all net imports of electricity, and, from 1989, includes only the portion of imports of electricity that is derived from hydroelectric power.

[e] "Other" is geothermal, wind, photovoltaic, and solar thermal energy. From 1989, includes net imports of electricity generated from geothermal energy. See Appendix A, Section 5, for explanation of estimation methodology.

[f] Net interstate flow of electricity is the difference between the amount of energy in the electricity sold within a State (including associated losses) and the energy input at the electric utilities within the State. A positive number indicates that more electricity (including associated losses) came into the State than went out of the State during the year; conversely, a negative number indicates that more electricity (including associated losses) went out of the State than came into the State.

[g] From 1989, "Total" does not equal the sum of the columns. Net imports of electricity generated from nonrenewable energy sources (shown in appendix Table A8) is included in the total but not in any other columns.

[h] There is a discontinuity in this time series between 1988 and 1989 due to the expanded coverage of renewable energy sources beginning in 1989.

kWh=kilowatthours. R=Revised data. — =Not applicable.

(s)=Btu value less than 0.05 and physical unit value less than 0.5.

Note: Totals may not equal sum of components due to independent rounding.

Sources: Data sources, estimation procedures, and assumptions are described in the appendices to this report.

Table 42. Residential Energy Consumption Estimates, Selected Years 1960-1999, California

Year	Coal [a]	Natural Gas [b]	Petroleum				Wood	Geothermal	Solar [c]	Electricity [a]	Net Energy	Electrical System Energy Losses [d]	Total
			Distillate Fuel [a]	Kerosene [a]	LPG [a]	Total							
	Thousand Short Tons	Billion Cubic Feet	Thousand Barrels				Thousand Cords			Million Kilowatthours		Million Kilowatthours	
1960	2	365	485	15	3,778	4,277	1,263	—	—	14,975	—	37,248	—
1965	4	489	427	31	5,095	5,553	1,083	—	—	23,800	—	56,824	—
1970	38	553	500	166	5,167	5,833	1,209	—	—	35,777	—	86,700	—
1975	0	631	493	211	2,708	3,412	1,374	—	—	44,257	—	106,754	—
1980	1	529	94	18	4,919	5,032	R 3,550	—	—	52,011	—	126,473	—
1985	19	527	148	73	5,350	5,571	4,083	—	—	57,501	—	135,093	—
1990	9	515	226	88	5,750	6,064	3,174	—	—	66,575	—	R 145,639	—
1991	16	509	199	80	6,952	7,231	3,344	—	—	66,017	—	R 143,516	—
1992	(s)	480	201	33	4,802	5,036	3,519	—	—	68,121	—	R 145,287	—
1993	50	501	155	67	5,035	5,257	2,983	—	—	67,359	—	R 142,272	—
1994	58	521	148	67	4,953	5,168	2,924	—	—	68,866	—	R 143,719	—
1995	46	477	129	81	4,884	5,094	3,246	—	—	68,783	—	R 143,408	—
1996	62	473	101	103	4,079	4,283	3,240	—	—	71,396	—	R 148,790	—
1997	38	479	125	135	R 3,686	R 3,945	R 1,883	—	—	73,086	—	R 152,027	—
1998	40	550	156	237	6,092	6,485	1,660	—	—	74,792	—	154,505	—
1999	10	568	101	187	5,711	6,000	1,779	—	—	75,303	—	147,542	—
			Trillion Btu										
1960	0.1	377.6	2.8	0.1	15.2	18.1	25.3	0.0	0.0	51.1	472.0	127.1	599.1
1965	0.1	524.9	2.5	0.2	20.4	23.1	21.7	0.0	0.0	81.2	650.9	193.9	844.8
1970	0.8	582.4	2.9	0.9	19.5	23.4	24.2	0.0	0.0	122.1	752.9	295.8	1,048.7
1975	0.0	666.7	2.9	1.2	10.1	14.1	27.5	0.0	0.0	151.0	859.3	364.2	1,223.6
1980	(s)	552.4	0.6	0.1	18.1	18.7	R 71.0	0.0	0.0	177.5	R 819.6	431.5	R 1,251.2
1985	0.4	547.8	0.9	0.4	19.3	20.6	81.7	0.0	0.0	196.2	846.6	460.9	1,307.6
1990	0.2	530.8	1.3	0.5	20.8	22.7	63.5	e 0.2	R e 18.4	227.2	R e 862.9	R 496.9	R e 1,359.8
1991	0.4	522.3	1.2	0.5	25.1	26.7	66.9	0.2	R 19.1	225.2	R 860.8	R 489.7	R 1,350.4
1992	(s)	492.7	1.2	0.2	17.4	18.8	70.4	0.2	R 19.6	232.4	R 834.1	R 495.7	R 1,329.8
1993	1.2	519.9	0.9	0.4	18.2	19.4	59.7	0.2	R 20.1	229.8	R 850.3	R 485.4	R 1,335.7
1994	1.4	531.7	0.9	0.4	18.0	19.2	58.5	0.2	R 20.4	235.0	R 866.3	R 490.4	R 1,356.7
1995	1.1	483.8	0.8	0.5	17.7	18.9	64.9	0.2	R 20.5	234.7	R 824.0	R 489.3	R 1,313.4
1996	1.4	489.1	0.6	0.6	14.7	15.9	64.8	0.2	R 20.5	243.6	R 835.5	R 507.7	R 1,343.2
1997	0.9	487.4	0.7	0.8	R 13.3	R 14.8	R 37.7	0.2	R 20.1	249.4	R 810.4	R 518.7	R 1,329.2
1998	0.9	578.3	0.9	1.3	22.0	24.3	33.2	0.2	19.7	255.2	911.8	527.2	1,439.0
1999	0.2	578.6	0.6	1.1	20.7	22.3	35.6	0.1	19.0	256.9	912.8	503.4	1,416.2

[a] The continuity of these data series estimates may be affected by changing data sources and estimation methodologies. See the "Additional Notes" under each type of energy in Appendix A.

[b] Includes supplemental gaseous fuels.

[c] Includes small amounts of solar thermal and photovoltaic energy consumed by the commercial sector that cannot be separately identified. See Appendix A, Section 5, for explanation of estimation methodology.

[d] Incurred in the generation, transmission, and distribution of electricity plus plant use and unaccounted for electrical system energy losses.

[e] There is a discontinuity in this time series between 1988 and 1989 due to the expanded coverage of renewable energy sources beginning in 1989.

R=Revised data.

— =Not applicable.

(s)=Btu value less than 0.05 and physical unit value less than 0.5.

Note: Totals may not equal sum of components due to independent rounding.

Sources: Data sources, estimation procedures, and assumptions are described in the appendices to this report.

Table 43. Commercial Energy Consumption Estimates, Selected Years 1960-1999, California

Year	Coal[a]	Natural Gas[b]	Petroleum						Wood	Geothermal	Electricity[a]	Net Energy	Electrical System Energy Losses[c]	Total[d]
			Distillate Fuel[a]	Kerosene[a]	LPG[a]	Motor Gasoline	Residual Fuel[a]	Total						
	Thousand Short Tons	Billion Cubic Feet	Thousand Barrels						Thousand Cords		Million Kilowatthours		Million Kilowatthours	
1960	4	109	637	46	667	1,406	7,284	10,040	24	—	22,039	—	54,819	—
1965	7	164	560	95	899	1,309	6,200	9,064	20	—	29,917	—	71,430	—
1970	71	210	657	510	912	1,482	8,631	12,192	23	—	40,634	—	98,471	—
1975	0	240	647	650	478	1,622	4,377	7,774	26	—	57,846	—	139,532	—
1980	3	258	3,225	222	868	1,795	6,811	12,921	85	—	63,465	—	154,326	—
1985	34	205	3,513	353	944	1,759	35	6,604	R 109	—	73,592	—	172,897	—
1990	16	285	4,588	19	1,015	1,928	895	8,444	R 202	—	88,311	—	R 193,190	—
1991	29	288	4,449	23	1,227	1,647	764	8,110	R 213	—	86,098	—	R 187,170	—
1992	(s)	285	1,994	20	847	1,485	43	4,390	R 229	—	87,849	—	R 187,363	—
1993	92	250	1,591	19	889	262	18	2,779	240	—	86,544	—	R 182,795	—
1994	108	262	1,505	12	874	226	8	2,625	245	—	84,529	—	R 176,405	—
1995	86	279	2,334	27	862	236	4	3,463	245	—	86,032	—	R 179,371	—
1996	115	235	1,743	69	720	231	12	2,775	R 266	—	88,605	—	R 184,653	—
1997	71	254	1,955	41	R 650	233	2	R 2,881	R 207	—	92,295	—	R 191,984	—
1998	75	282	2,451	63	1,075	250	63	3,901	207	—	92,228	—	190,524	—
1999	18	245	1,624	29	1,008	236	0	2,897	249	—	95,771	—	187,645	—
			Trillion Btu											
1960	0.1	112.7	3.7	0.3	2.7	7.4	45.8	59.8	0.5	0.0	75.2	248.3	187.0	435.3
1965	0.2	175.5	3.3	0.5	3.6	6.9	39.0	53.3	0.4	0.0	102.1	331.4	243.7	575.1
1970	1.6	221.3	3.8	2.9	3.4	7.8	54.3	72.2	0.5	0.0	138.6	434.2	336.0	770.1
1975	0.0	253.7	3.8	3.7	1.8	8.5	27.5	45.3	0.5	0.0	197.4	496.8	476.1	972.9
1980	0.1	269.4	18.8	1.3	3.2	9.4	42.8	75.5	1.7	0.0	216.5	563.2	526.6	1,089.8
1985	0.8	212.9	20.5	2.0	3.4	9.2	0.2	35.3	R 2.2	0.0	251.1	R 502.3	589.9	R 1,092.3
1990	0.4	294.1	26.7	0.1	3.7	10.1	5.6	46.3	R 4.0	e 0.3	301.3	R e 646.4	R 659.2	R e 1,305.6
1991	0.7	295.3	25.9	0.1	4.4	8.7	4.8	43.9	R 4.3	0.3	293.8	R 638.2	R 638.6	R 1,276.9
1992	(s)	292.8	11.6	0.1	3.1	7.8	0.3	22.9	R 4.6	0.3	299.7	R 620.4	R 639.3	R 1,259.7
1993	2.1	259.8	9.3	0.1	3.2	1.4	0.1	14.1	4.8	0.3	295.3	576.4	R 623.7	R 1,200.1
1994	2.5	267.4	8.8	0.1	3.2	1.2	(s)	13.2	4.9	0.3	288.4	576.8	R 601.9	1,178.7
1995	2.0	282.4	13.6	0.2	3.1	1.2	(s)	18.1	4.9	0.4	293.5	601.4	R 612.0	R 1,213.4
1996	2.7	242.9	10.2	0.4	2.6	1.2	0.1	14.4	5.3	0.5	302.3	568.1	R 630.0	R 1,198.1
1997	1.6	258.4	11.4	0.2	R 2.4	1.2	(s)	R 15.2	R 4.1	0.5	314.9	R 594.8	R 655.0	R 1,249.9
1998	1.7	296.7	14.3	0.4	3.9	1.3	0.4	20.2	4.1	0.7	314.7	638.1	650.1	1,288.2
1999	0.4	249.1	9.5	0.2	3.6	1.2	0.0	14.5	5.0	0.5	326.8	596.3	640.2	1,236.5

[a] The continuity of these data series estimates may be affected by changing data sources and estimation methodologies. See the "Additional Notes" under each type of energy in Appendix A.

[b] Includes supplemental gaseous fuels.

[c] Incurred in the generation, transmission, and distribution of electricity plus plant use and unaccounted for electrical system energy losses.

[d] Small amounts of solar thermal and photovoltaic energy consumed in the commercial sector cannot be separately identified and are included in residential consumption.

[e] There is a discontinuity in this time series between 1988 and 1989 due to the expanded coverage of renewable energy sources beginning in 1989.

R=Revised data.

— =Not applicable.

(s)=Btu value less than 0.05 and physical unit value less than 0.5.

Note: Totals may not equal sum of components due to independent rounding.

Sources: Data sources, estimation procedures, and assumptions are described in the appendices to this report.

Table 44. Industrial Energy Consumption Estimates, Selected Years 1960-1999, California

Year	Coal	Natural Gas [a]	Petroleum									Hydro-electric Power [b]	Wood and Waste	Other [b,d]	Electricity [b]	Net Energy	Electrical System Energy Losses [e]	Total
			Asphalt and Road Oil [b]	Distillate Fuel [b]	Kero-sene [b]	LPG [b]	Lubri-cants [b]	Motor Gasoline	Residual Fuel [b]	Other [b,c]	Total							
	Thousand Short Tons	Billion Cubic Feet	Thousand Barrels									Million kWh			Million kWh		Million kWh	
1960	1,313	451	10,665	10,127	956	4,231	1,454	2,851	10,750	R 25,691	R 66,725	(s)	—	—	20,190	—	50,221	—
1965	2,361	529	11,892	13,002	692	4,826	1,709	2,245	11,846	R 28,664	R 74,876	(s)	—	—	28,904	—	69,012	—
1970	2,215	711	12,084	8,510	328	9,147	1,510	1,942	12,121	R 35,824	R 81,466	(s)	—	—	42,169	—	102,190	—
1975	2,151	666	13,146	10,519	1,166	15,688	1,246	1,338	8,308	R 39,478	R 90,890	0	—	—	46,053	—	111,086	—
1980	2,665	486	18,431	15,576	1,877	12,887	2,103	1,698	12,554	R 49,455	R 114,581	0	—	—	51,888	—	126,174	—
1985	1,889	433	13,848	18,285	491	12,977	1,914	3,065	18,732	R 55,165	R 124,477	0	—	—	52,972	—	124,454	—
1990	2,874	588	14,862	19,138	38	12,304	2,153	3,163	1,864	R 54,940	R 108,462	R [f] 990	—	—	55,892	—	R 122,268	—
1991	2,771	707	14,251	14,329	36	9,658	1,926	3,271	1,762	R 45,165	R 90,398	R 1,368	—	—	56,191	—	R 122,155	—
1992	2,821	687	13,558	11,101	23	14,788	1,964	3,297	1,889	R 48,344	R 94,964	R 1,476	—	—	57,090	—	R 121,759	—
1993	2,311	747	12,433	8,779	44	10,073	2,000	2,664	1,539	R 43,672	R 81,205	R 2,511	—	—	56,189	—	R 118,680	—
1994	2,332	726	12,237	9,028	40	11,266	2,090	2,758	1,353	R 45,397	R 84,169	R 1,091	—	—	59,864	—	R 124,931	—
1995	2,485	754	12,212	8,607	56	8,489	2,054	2,849	1,489	R 42,389	R 78,145	R 3,049	—	—	57,367	—	R 119,607	—
1996	2,140	761	12,399	8,078	122	R 5,634	1,994	2,741	309	R 46,392	R 77,670	R 2,919	—	—	57,683	—	R 120,211	—
1997	2,026	812	11,512	11,031	182	R 4,169	2,106	2,910	104	R 44,442	R 76,456	R 1,220	—	—	62,017	—	R 129,001	—
1998	2,688	900	15,572	11,849	174	3,100	2,205	3,263	33	38,703	74,899	2,073	—	—	58,856	—	121,584	—
1999	2,755	1,175	20,366	8,737	73	5,068	2,228	1,922	684	39,220	78,298	1,508	—	—	63,217	—	123,861	—
			Trillion Btu															
1960	35.2	466.3	70.8	59.0	5.4	17.0	8.8	15.0	67.6	R 153.9	R 397.5	(s)	56.3	0.0	68.9	R 1,024.2	171.4	R 1,195.5
1965	63.2	567.4	78.9	75.7	3.9	19.4	10.4	11.8	74.5	R 168.7	R 443.3	(s)	74.8	0.0	98.6	R 1,247.3	235.5	R 1,482.8
1970	59.3	749.1	80.2	49.6	1.9	34.6	9.2	10.2	76.2	R 210.6	R 472.3	(s)	91.7	0.0	143.9	R 1,516.4	348.7	R 1,865.0
1975	56.4	703.6	87.2	61.3	6.6	58.3	7.6	7.0	52.2	R 232.3	R 512.5	0.0	99.3	0.0	157.1	R 1,529.0	379.0	R 1,908.0
1980	66.1	507.4	122.3	90.7	10.6	47.3	12.8	8.9	78.9	R 289.5	R 661.2	0.0	R 61.1	0.0	177.0	R 1,472.7	430.5	R 1,903.3
1985	44.0	449.5	91.9	106.5	2.8	46.8	11.6	16.1	117.8	R 327.2	R 720.6	0.0	R 71.6	0.0	180.7	R 1,466.5	424.6	R 1,891.1
1990	64.7	606.5	98.6	111.5	0.2	44.6	13.1	16.6	11.7	R 323.2	R 619.5	R [f] 10.3	R 128.6	R [f] 172.5	190.7	R [f] 1,792.9	R 417.2	R [f] 2,210.1
1991	63.0	725.7	94.6	83.5	0.2	34.9	11.7	17.2	11.1	R 267.9	R 521.0	R 14.3	R 114.6	R 185.0	191.7	R 1,815.3	R 416.8	R 2,232.1
1992	64.8	705.7	90.0	64.7	0.1	53.6	11.9	17.3	11.9	R 284.6	R 534.1	R 15.3	R 122.8	R 187.4	194.8	R 1,824.7	R 415.4	R 2,240.2
1993	53.6	775.3	82.5	51.1	0.3	36.3	12.1	14.0	9.7	R 258.3	R 464.3	R 25.9	R 116.4	R 203.3	191.7	R 1,830.6	R 404.9	R 2,235.5
1994	54.2	741.4	81.2	52.6	0.2	41.0	12.7	R 14.4	8.5	R 268.4	R 478.9	R 11.3	R 122.7	R 212.7	204.3	R 1,825.3	R 426.3	2,251.6
1995	57.9	764.3	81.0	50.1	0.3	30.8	12.5	R 14.9	9.4	R 250.9	R 449.8	R 31.4	R 106.4	R 205.4	195.7	R 1,811.0	R 408.1	R 2,219.1
1996	49.8	786.7	82.3	47.1	0.7	R 20.4	12.1	R 14.3	1.9	R 275.4	R 454.1	R 30.2	R 104.5	R 211.9	196.8	R 1,834.0	R 410.2	R 2,244.1
1997	46.7	825.9	76.4	64.3	1.0	R 15.1	12.8	R 15.2	0.7	R 263.9	R 449.3	R 12.6	R 109.7	R 195.1	211.6	R 1,851.0	R 440.2	R 2,291.1
1998	61.8	946.7	103.3	69.0	1.0	11.2	13.4	17.0	0.2	230.1	445.2	21.4	93.8	202.3	200.8	1,972.1	414.8	2,387.0
1999	63.4	1,196.3	135.1	50.9	0.4	18.3	13.5	10.0	4.3	232.5	465.1	15.6	120.3	324.8	215.7	2,401.1	422.6	2,823.7

[a] Includes supplemental gaseous fuels.

[b] The continuity of these data series estimates may be affected by changing data sources and estimation methodologies. See the "Additional Notes" under each type of energy in Appendix A.

[c] "Other" is the subtotal of 16 petroleum products. See a full description in Appendix A, Section 4, "Other Petroleum Products."

[d] "Other" is geothermal, wind, photovoltaic, and solar thermal energy. See Appendix A, Section 5, for explanation of estimation methodology.

[e] Incurred in the generation, transmission, and distribution of electricity plus plant use and unaccounted for electrical system energy losses.

[f] There is a discontinuity in this time series between 1988 and 1989 due to the expanded coverage of renewable energy sources beginning in 1989.

R=Revised data.

kWh=kilowatthours. — =Not applicable.

(s)=Btu value less than 0.05 and physical unit value less than 0.5.

Note: Totals may not equal sum of components due to independent rounding.

Sources: Data sources, estimation procedures, and assumptions are described in the appendices to this report.

Table 45. Transportation Energy Consumption Estimates, Selected Years 1960-1999, California

Year	Coal [a]	Natural Gas [b]	Petroleum								Ethanol [c]	Electricity [a]	Net Energy	Electrical System Energy Losses [d]	Total [c]
			Aviation Gasoline [a]	Distillate Fuel [a]	Jet Fuel [a]	LPG [a]	Lubricants [a]	Motor Gasoline	Residual Fuel [a]	Total					
	Thousand Short Tons	Billion Cubic Feet	Thousand Barrels								Thousand Barrels	Million Kilowatthours		Million Kilowatthours	
1960	23	11	5,383	15,313	25,818	214	2,327	132,768	38,610	220,432	0	66	—	164	—
1965	8	16	3,342	21,032	40,150	208	2,772	166,346	35,109	268,960	0	66	—	158	—
1970	4	17	2,184	29,448	59,614	305	2,457	210,641	27,982	332,632	0	65	—	158	—
1975	(s)	20	1,640	30,528	62,509	390	2,386	238,548	20,056	356,057	0	265	—	639	—
1980	0	15	285	41,801	62,224	522	2,804	250,100	66,673	424,409	0	203	—	493	—
1985	0	14	1,354	50,177	67,028	1,225	2,552	262,544	43,340	428,219	R e 429	266	—	625	—
1990	0	20	1,106	58,418	94,907	923	2,871	300,893	54,963	514,080	R 1,133	315	—	690	—
1991	0	19	1,091	56,328	90,064	760	2,568	293,780	42,113	486,703	R 1,424	345	—	R 750	—
1992	0	15	1,059	53,839	86,688	650	2,619	310,861	32,282	487,997	R 158	387	—	R 826	—
1993	0	12	819	48,455	89,244	658	2,666	305,800	32,831	480,474	R 575	408	—	861	—
1994	0	13	793	54,137	98,793	1,006	2,787	304,669	38,310	500,495	R 810	425	—	887	—
1995	0	20	807	57,540	95,305	564	2,739	310,379	44,729	512,062	R 2,523	423	—	882	—
1996	0	20	769	57,352	103,773	R 481	2,658	315,285	39,644	R 519,961	R 2,128	429	—	R 894	—
1997	0	25	R 836	62,403	103,144	R 349	2,808	319,727	21,714	R 510,982	R 2,134	478	—	R 994	—
1998	0	11	574	64,305	105,385	670	2,940	326,430	18,176	518,480	1,610	521	—	1,076	—
1999	0	13	825	64,078	98,673	384	2,971	335,633	27,881	530,446	1,395	540	—	1,058	—
			Trillion Btu												
1960	0.6	11.0	27.2	89.2	140.7	0.9	14.1	697.4	242.7	1,212.2	0.0	0.2	1,223.9	0.6	1,224.5
1965	0.2	16.8	16.9	122.5	222.2	0.8	16.8	873.8	220.7	1,473.8	0.0	0.2	1,491.0	0.5	1,491.5
1970	0.1	17.9	11.0	171.5	332.9	1.2	14.9	1,106.5	175.9	1,814.0	0.0	0.2	1,832.2	0.5	1,832.7
1975	(s)	21.4	8.3	177.8	350.2	1.5	14.5	1,253.1	126.1	1,931.4	0.0	0.9	1,953.7	2.2	1,955.9
1980	0.0	15.9	1.4	243.5	348.7	1.9	17.0	1,313.8	419.2	2,345.5	0.0	0.7	2,362.1	1.7	2,363.8
1985	0.0	15.0	6.8	292.3	375.8	4.4	15.5	1,379.1	272.5	2,346.5	R e 1.5	0.9	e 2,362.3	2.1	e 2,364.5
1990	0.0	20.8	5.6	340.3	534.7	3.3	17.4	1,580.6	345.6	2,827.4	R 4.0	1.1	2,849.3	2.4	2,851.6
1991	0.0	19.0	5.5	328.1	508.1	2.7	15.6	1,543.2	264.8	2,668.0	R 5.0	1.2	2,688.2	2.6	2,690.8
1992	0.0	15.2	5.3	313.6	489.5	2.4	15.9	1,633.0	203.0	2,662.7	R 0.6	1.3	2,679.2	2.8	2,682.0
1993	0.0	12.5	4.1	282.3	504.7	2.4	16.2	1,606.4	206.4	2,622.4	R 2.0	1.4	2,636.3	2.9	2,639.3
1994	0.0	12.9	4.0	315.3	560.1	3.7	16.9	R 1,593.4	240.9	R 2,734.3	R 2.9	1.5	R 2,748.7	3.0	R 2,751.7
1995	0.0	20.0	4.1	335.2	540.4	2.0	16.6	R 1,618.6	281.2	R 2,798.1	R 8.9	1.4	R 2,819.6	3.0	R 2,822.6
1996	0.0	20.2	3.9	334.1	588.4	R 1.7	16.1	R 1,644.5	249.2	R 2,838.0	R 7.5	1.5	R 2,859.6	3.0	R 2,862.7
1997	0.0	25.1	4.2	363.5	584.8	R 1.3	17.0	R 1,666.7	136.5	R 2,774.1	R 7.6	1.6	R 2,800.8	3.4	R 2,804.2
1998	0.0	11.9	2.9	374.6	597.5	2.4	17.8	1,701.4	114.3	2,810.9	5.7	1.8	2,824.6	3.7	2,828.2
1999	0.0	12.9	4.2	373.3	559.5	1.4	18.0	1,749.0	175.3	2,880.6	4.9	1.8	2,895.3	3.6	2,898.9

[a] The continuity of these data series estimates may be affected by changing data sources and estimation methodologies. See the "Additional Notes" under each type of energy in Appendix A.

[b] Includes supplemental gaseous fuels. Transportation use of natural gas is gas consumed in the operation of pipelines, primarily in compressors, and, since 1990, is also gas consumed as vehicle fuel.

[c] Ethanol blended into motor gasoline, which is accounted for under motor gasoline, is shown separately here to display the use of renewable energy by the transportation sector and is included only once in the total.

[d] Incurred in the generation, transmission, and distribution of electricity plus plant use and unaccounted for electrical system energy losses.

[e] There is a discontinuity in this time series between 1980 and 1981 due to the expanded coverage of renewable energy sources beginning in 1981.

R=Revised data.

— =Not applicable.

(s)=Btu value less than 0.05 and physical unit value less than 0.5.

Note: Totals may not equal sum of components due to independent rounding.

Sources: Data sources, estimation procedures, and assumptions are described in the appendices to this report.

Credits and Web Locations

The energy flow charts prepared by Lawrence Livermore National Laboratory are available on the Web at http://en-env.llnl.gov/flow/ .

The Energy Information Administration's Website is http://www.eia.doe.gov/ .

The California Energy Commission's Website is http://www.energy.ca.gov/ .

Graphic artist: **Helen Magann**

University of California
Lawrence Livermore National Laboratory
Technical Information Department
Livermore, CA 94551